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ABSTRACT

This article discusses some of the advantages of computer-based testing and highlights efforts by several states and organizations to introduce electronic assessment. It also describes the challenges policymakers face in planning and implementing such an initiative and details the steps they can take to pursue this type of testing. As electronic learning becomes more widespread, the substance and format of assessment will need to keep pace. Once the infrastructure is in place, electronic processing can help large-scale assessment programs develop and deliver tests and present new types of test materials. Electronic processing can transmit responses to essay and other open-ended questions for human or computer scoring, and it can distribute test results. In the K-12 area, at least six states are moving assessments to Web delivery, and at least four states have initiated large-scale assessment projects that involve multiple subject areas and grades. The ultimate impact of the new technology may be to change fundamentally how educational assessment is thought about and done. Getting there will not be easy, but policymakers can take these steps to reduce the risks of technology-based assessment: (1) review the initiatives of other states; (2) establish cooperative arrangements; (3) develop a comprehensive multi-year plan; (4) build experimentation into the assessment plan; (5) involve people who can think creatively; (6) plan for a single technology infrastructure; (7) use the assessment for the purposes for which it was designed; (8) plan to go beyond delivering conventional tests by computer; and (9) do not forget why electronic assessment is desired. (Contains 26 references.) (SLD)

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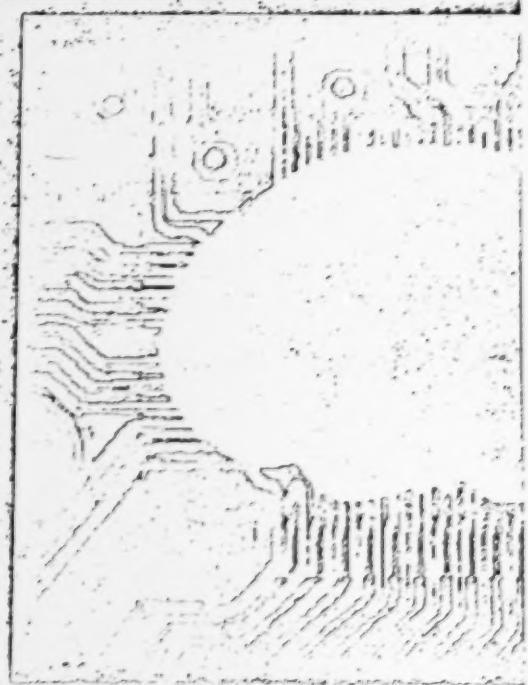
online testing

Using Electronic Assessment to Measure Student Performance



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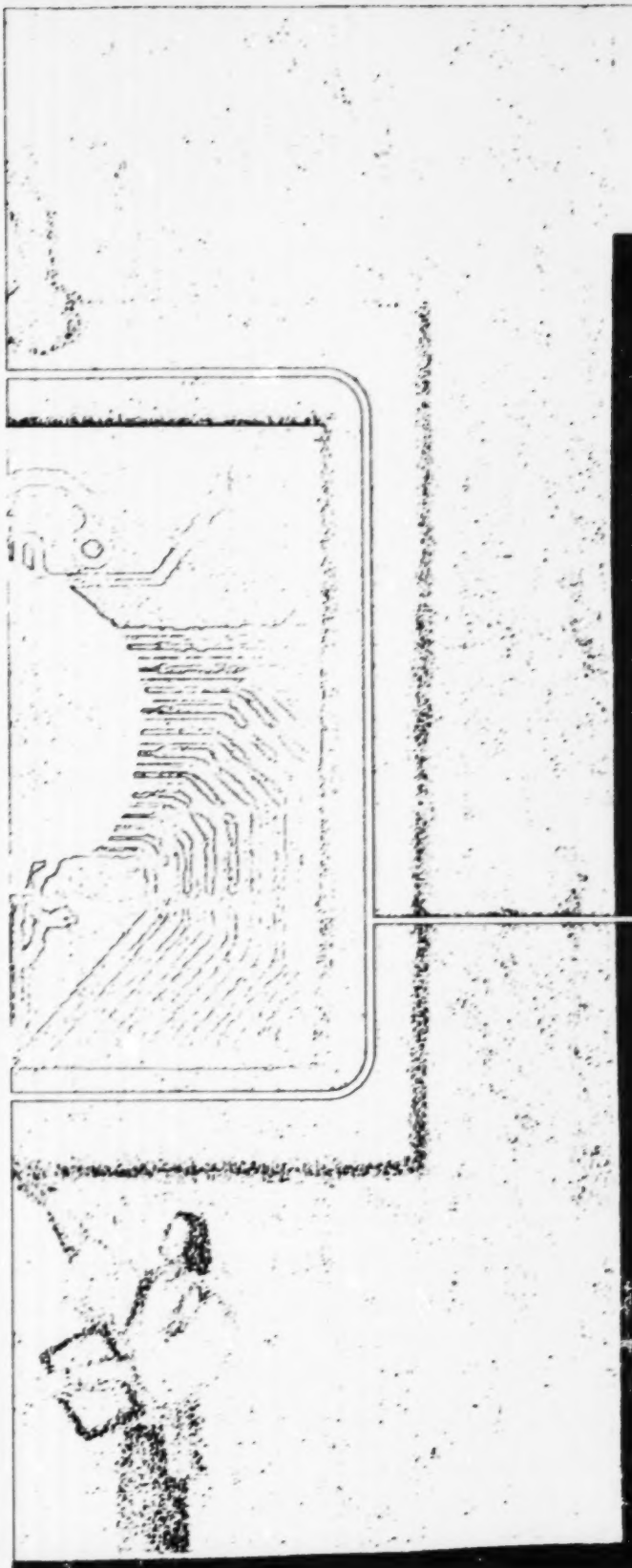

Paper-and-pencil measures > > > dominate testing in the nation's elementary and secondary schools. As demands for greater school accountability and student achievement continue to increase, the shortcomings of these measures in a knowledge-based economy are becoming more evident. For example, paper-and-pencil testing programs provide results too slowly to guide state policy or classroom instruction effectively. Perhaps more seriously, changes in what and how students learn are outpacing the capabilities of conventional tests. This development results from the influx of technology into the workplace and into education; skill in technology is becoming both a workforce requirement and an essential academic tool (e.g., for research, writing, simulation, and data visualization).

The benefits of electronic assessment are clear. By using this technology to measure student performance, state policymakers can speed the return of test results to teachers so they inform instruction. In addition, the technology can help customize learning and assessment. Finally, the use of electronic assessment may allow educators to integrate assessment with instruction to produce powerful learning tools.

The recent passage of the No Child Left Behind Act with its increased testing mandates requires state policymakers to consider more effective strategies for measuring student performance.

by Randy Elliot Bennett > > >

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As students do more of their learning using technology tools, asking them to express that learning in a medium different from the one they typically work in will become increasingly untenable.

Electronic assessment is one such strategy. However, the transition to electronic assessment raises significant policy and implementation issues. This article discusses some of the advantages of computer-based testing and highlights efforts by several states and organizations to introduce electronic assessment. It also describes the challenges policymakers face in planning and implementing such an initiative and details the steps they can take to pursue this type of testing.

What Is Happening to Education

To fully appreciate the need for electronic state assessment, it is important to understand that seminal changes are occurring in the workplace and in postsecondary education, areas that strongly influence K-12 schooling. During the past few decades, employer demand has shifted toward workers with higher education credentials, as indicated by the higher wages paid to those with a college degree.[1] Yet, in addition to this rise in entry qualifications, the knowledge required to maintain a job in many occupations is changing so fast it is estimated that 50 percent of all job skills become outdated within three to five years.[2] Moreover, positions that require interaction with information technology comprise a growing proportion of jobs. By 2006 almost half of all workers will be employed by industries that are major producers or intensive users of information technology products and services.[3]

The need to continuously upgrade skills and the pay differential associated with increased education is causing many adults to return to school. Consequently, it is not surprising that the adult cohort is the fastest-growing segment in postsecondary education,[4] with working adults above age 24 comprising some 44 percent of college students.[5] This population's need for higher education is increasingly becoming the target of distance learning. More than 1,000 U.S. colleges and universities already offer courses on the Internet.[6] As of 2000, U.S. institutions reportedly offered more than 6,000 accredited courses electronically. By 2002, more than two million students will be enrolled in online learning programs, representing a tripling of 1998 enrollment.[7] The nation's economic competitors have gotten the message—China plans to have five million students enrolled in 50 to 100 online colleges by 2005.[8]

At the same time, Internet-based distance learning is finding its way into U.S. high schools. Home-schooled students, school districts without enough qualified teachers, and the children of migrant workers are generating the need for "virtual high schools," which have been or are being developed by seventeen states.[9] These programs can cross state lines, with course offerings open to students regardless of residence. Once a virtual high school is accredited, as some now are, students can apply their course grades toward high school graduation.

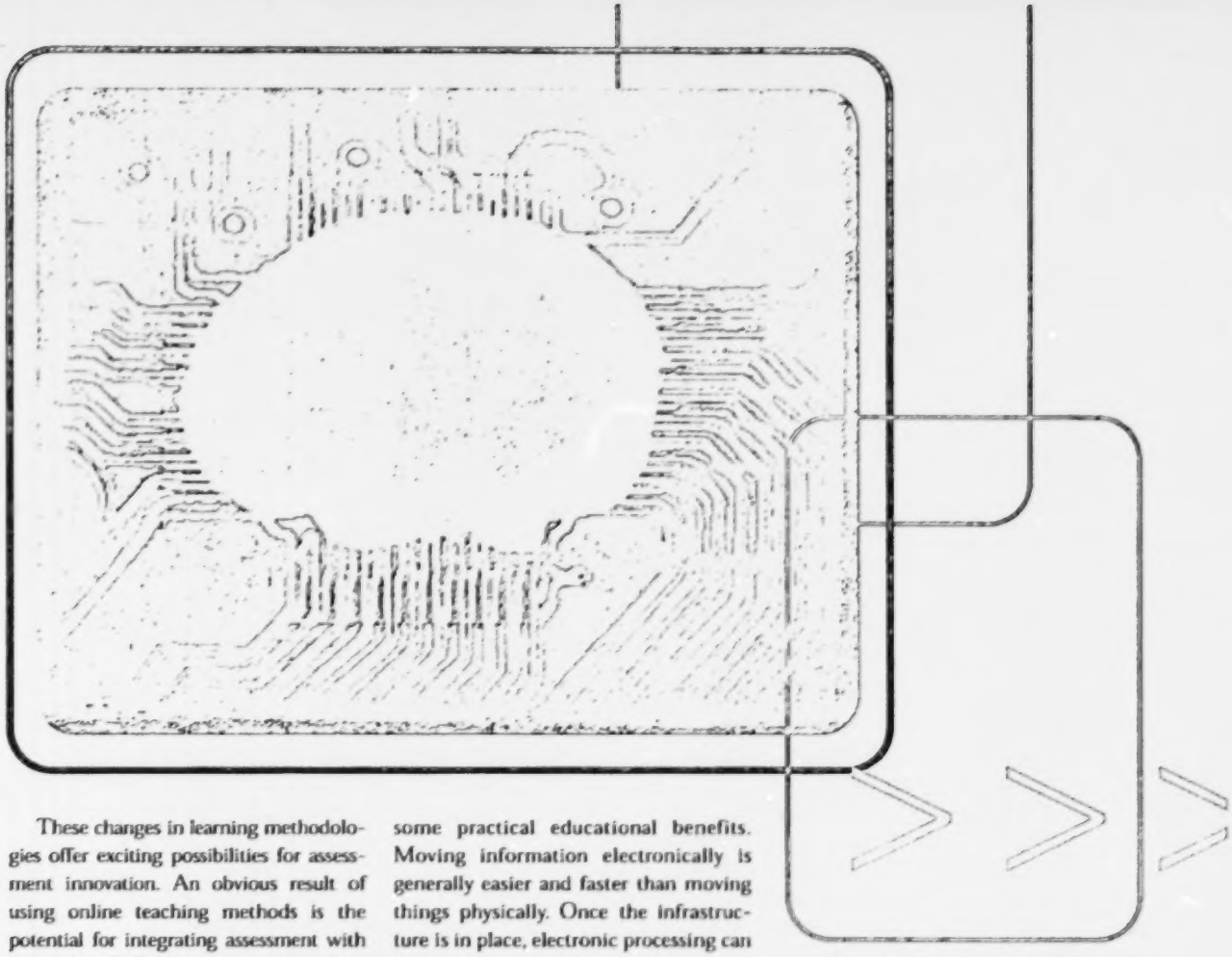
The growth of Internet-based distance learning will have a significant impact on traditional education. It will produce sophisticated software that everyone can use, blurring the distinctions between distance learning and local education. For example, APEX already serves about 50,000 students in 22 states.[10] It markets online advanced placement (AP) courses, targeting districts that want to offer AP but lack qualified teachers. Participating districts use APEX offerings onsite.

The considerable potential of online learning—whether local or distance—is reflected in a report from the Commission on Technology and Adult Learning, sponsored by the American Society for Training and Development and the National Governors Association. The report states, "The commission ... encourages governors, CEOs and other leaders to make e-learning the cornerstone of a national effort to develop a skilled workforce for America's digital economy.... By embracing e-learning in our states, our communities, and our organizations, we can improve our competitiveness and point the way to a new era of unprecedented growth and opportunity for all Americans."[11]

What Electronic Learning Means for Testing

If the recommendations of this and other commission reports are acted on, the consequences for assessment are profound. As electronic learning becomes more widespread, the substance and format of assessment will need to keep pace. The Web-based Education Commission states, "Perhaps the greatest barrier to innovative teaching is assessment that measures yesterday's learning goals.... Too often today's tests measure yesterday's skills with yesterday's testing technologies—paper and pencil."[12]

As students do more of their learning using technology tools, asking them to express that learning in a medium different from the one they typically work in will become increasingly untenable. This is especially true if working with technology (e.g., searching for information using the Internet or writing on a computer) is part of the skill set being tested.



These changes in learning methodologies offer exciting possibilities for assessment innovation. An obvious result of using online teaching methods is the potential for integrating assessment with instruction.[13] Students will respond to online instructional exercises electronically, so their responses can be recorded. This learning "trail" can be analyzed to indicate what each student knows and needs to learn next, enabling instruction to be tailored to individual learning needs.

In addition to assessment embedded in Internet-delivered courses, one can imagine Internet-delivered assessment embedded in more traditional classroom activity. Such assessment could take the form of periodic exercises that both teach and test. In this scenario, the exercises would be standardized and performance could serve, depending on the level of aggregation, to indicate individual, classroom, school, district, state, or national achievement. These Web-based exercises could serve accountability as well as diagnostic purposes and be useful to individuals and institutions.

Besides enabling testing to inform instruction, the new technology offers some practical educational benefits. Moving information electronically is generally easier and faster than moving things physically. Once the infrastructure is in place, electronic processing can help large-scale assessment programs accomplish the following:

- **Develop tests.** Computer technology makes questions easier and cheaper to write. With inexpensive, high-quality test questions, teachers will have better resources for classroom assessment and students will have more opportunities to practice critical skills.
- **Deliver tests.** Computer delivery enables tests to be individually administered. Different tests can be administered simultaneously to different students in the same classroom. Special accommodations, such as extended time, can be made for those with disabilities.
- **Present new types of test questions that include audio, video, and animation.** This capability makes it possible to measure important skills that paper-and-pencil tests simply cannot assess (e.g., skill in using computers to search for information). It also makes the need for specialized testing equipment, such as audiocassette recorders and VCRs, obsolete.[14]
- **Transmit responses to essay and other open-ended questions** to human graders for scoring on computer terminals or to programs that can score such questions automatically.[15] These capabilities make it practical to include more open-ended questions in state assessments because the cost and time required for grading are greatly reduced. Including more open-ended questions will encourage students and teachers to focus on problem-solving activities that are more like the ones required for success in work and advanced academic environments.
- **Distribute test results.** With electronic distribution, parents, stu-

dents, and decisionmakers can get results faster. In addition, parents can try sample questions and get immediate feedback, giving them a better understanding of the skills that state assessments measure.

What Is Happening with Testing and Technology

Who is delivering tests by computer? The list is impressive and includes nonprofit testing agencies, for-profit testing companies, school districts, state education departments, government agencies, and companies with no history in testing.[16] In the K-12 arena, at least six states are moving assessments to Web delivery. These states appear to have varying goals, timelines, and implementation strategies. Most of these initiatives are just beginning, so many details are not yet available.

At least four states have initiated large-scale assessment projects that involve multiple subject areas and grades. South Dakota appears to be furthest along. The state began delivering the Dakota Assessment of Content Standards (DACS) exclusively via the Web in April 2002.[17] DACS is a low-stakes, criterion-referenced assessment that aims to measure progress toward state content standards, assist schools in aligning their curricula, and improve student achievement. It is an "adaptive" test, meaning it is assembled from a large pool of questions as it is given. Later questions are based on how the student responds to earlier questions, so each student gets a unique assessment matched as closely as possible to his or her skill level.

DACS is mandatory in all schools for grades three, six, and ten in reading and math. Local staff has been trained to deliver the test and, in addition, 40 percent of the state's teachers have attended intensive "academies" on using technology in the curriculum. South Dakota has been able to move so quickly because state government has spent the past several years putting the infrastructure in place. Every classroom is wired with a high-speed Internet connection, and the ratio of students to computers is almost 2 to 1.

Oregon is developing its Web-based Technology Enhanced Student Assessment (TESA) to complement the existing criterion-referenced paper tests it uses for measuring progress toward the state's Certificate of Initial Mastery.[18] The certificate, which is not required for promotion or graduation, can be used in part to meet the entrance requirements for the state's university system. Students may take TESA or the paper assessment. If both tests are taken, the higher score is counted toward the certificate.

The state provides the test, reports the scores, trains school staff on the assessment, and evaluates TESA. Schools must provide computer equipment, physical space, and supervisory personnel. High-speed Internet access has already been installed in every school. TESA is being rolled out in phases. It became available in the 2001-2002 academic year at 300 elementary and secondary schools for third-, fifth-, eighth-, and tenth-grade mathematics and reading and language arts assessment. The tests should be available to all Oregon schools in these subjects, and in science and social studies, by the 2003-2004 school year.

The Virginia Standards of Learning (SOL) Technology Initiative aims to improve student achievement through the use of statewide Web-based computer resources.[19] The initiative, focusing first on high schools, has three goals: provide a ratio of one computer for every five students, create Internet-ready local area network capability in every school, and ensure high-bandwidth capabilities for the delivery of instructional, remedial, and testing services. All high schools will have access to instructional and remedial software by 2002. By spring 2004, all high schools should be capable of participating in Web-based assessment.

The Web-based eSOL assessment is composed of multiple-choice examinations in high school math, science, social studies, and English reading, literature, and research. The tests' purposes are to provide information on the progress of students and schools toward meeting achievement levels on the SOLs, offer information that can be used to improve instructional programs, and give assurances of the quality of public education.

Virginia's approach to implementing the eSOL tests is noteworthy. The state funded a demonstration in which three vendors tried out their Web-based test delivery strategies in nine schools during the spring of 2001. This trial let the state view the contractors in action and also identify what problems in Web delivery might exist regardless of technical strategy. At the end of the trial period, a contractor was selected for the statewide implementation.

Georgia will be offering two major testing programs via the Web. For grades one through eight, the Criterion-Referenced Competency Tests (CRCTs) will assess reading, mathematics, and English and language arts. Science and social studies will also be assessed in grades three through eight. The tests will be used to improve instruction and promote accountability. The reading and mathematics CRCT will eventually serve as a promotion requirement in grades three (reading only), five, and eight. Beginning in spring 2002, the tests are being offered in paper-and-pencil and Web-delivered formats.

The CRCT will reside in a Web-based question bank composed of three levels. Students will be granted access to a minimally secure level for self-assess-

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may be to fundamentally is thought about and done.

ment, remediation, and/or enrichment purposes. A second level will be accessible to teachers for evaluating student mastery of instructional sequences. The highly secure third level, accessible only during an annual window, will contain the end-of-year CRCT; only results from this third level will be reported to the state.

Georgia's second major testing program consists of eight, criterion-referenced, end-of-course tests (EOCT) in four high school subjects: math, science, English, and social studies. The tests will initially be offered in both paper-and-pencil and Web formats. EOCTs will be used to promote accountability and diagnose students' academic needs. Test results will be used to evaluate schools, will be included on student report cards, and will be part of high school graduation requirements.

Access to the Web-delivered EOCT bank will be available at two levels. The first level will consist of previously administered tests accessible to students, parents, and teachers for EOCT review, diagnostic, and remedial activities. The second level will consist of secure tests for accountability purposes. These tests will be administered during windows of opportunity in spring, summer, and winter. The first operational administrations, both Web and paper and pencil, are scheduled for the spring of 2003.

Besides these states, there are other trailblazers in electronic assessment. For example, the Northwest Evaluation Association markets the Measures of Academic Progress, which assesses reading, language, science, and mathematics. The computerized version of this test is used in 1,100 schools in 90 districts.[20] Another trailblazer is the Edison Schools, the largest private manager of public schools. The company recently introduced its Benchmark Assessment System, which provides teachers with ongoing, instructionally relevant information about the progress of their second- to eighth-grade students. These computerized assessments in reading, writing, mathematics, and language arts were administered more than one million times during the 2000-2001 academic year.[21]

What Is Next for Assessment

The ultimate impact of the new technology may be to fundamentally change how educational assessment is thought about and done. Some sense of this change can be gained by exploring how the Internet has affected the traditional commercial relationship between "richness" and "reach." Richness is the depth of the interaction that a business can have with a customer, and reach is the number of customers that a business can contact through a given medium. Traditionally, one limited the other; a business could attain maximal reach but only limited richness. For example, through direct mail, radio or television broadcasts, or newspaper advertisements, a company could communicate with many people but have a meaningful interaction with none of them. Similarly, a business could attain maximal richness but limited reach. Through personal contact (e.g., door-to-door sales), very deep interactions can occur, but only with a relatively small number of people.

What has the Internet done? It has transformed the traditional relationship between richness and reach by enabling businesses to touch many people in a personalized but inexpensive way.[22] What does richness with reach make for? It makes for mass customization. For example, on the Web, consumers can design a personal computer to their specifications[23] or create sneakers with the colors, graphics, and materials of their choice.[24]

Can assessment be customized? In very rudimentary ways, assessment is already customized. For example, in computerized adaptive tests, the difficulty level of the next question to administer is chosen in part on how the student has performed on the questions already given. The potential for customization in assessment is substantial. First, electronic networks could enable access to large resource banks containing test questions and instructional materials keyed to state standards, just as is planned in Georgia. Second, many of these test questions could be open-ended and automatically scored. Results from tests containing essay questions that used to take months to grade could be returned immediately.[25]

Teachers could draw from these banks to develop customized classroom tests. District or state assessment staff could use secure segments of the bank to construct accountability measures. These measures would not necessarily need to be administered as a single assessment in the spring or fall. Instead, these measures could be segmented into many parts, each one delivered on demand when the student is ready. Security could be maintained using automatic question-generation technologies that deliver different but comparably difficult tests to each student. Instructional and accountability measures could be administered frequently, closely linked to instruction, scored immediately, and returned to educators while there is still time to act on the results. In look and feel, there may be little difference between these instructional and accountability measures. The key differences are in who customizes each measure—a teacher or test developer—and in the stakes associated with one instrument or the other.

What are the implications for education? One implication is that education can be customized to individual students. With assessment closely tied to instruction and administered whenever needed, each student can move at a comfortable pace, using online resources to work on whatever skills have

yet to be mastered. A second implication relates to policymaking. If assessments can be administered frequently, decisionmakers will have access to almost up-to-the-minute descriptions of student performance statewide.

Why Getting There Will Not Be Easy

The experiences of states that are delivering or are moving toward delivering tests by computer make it clear that building a successful technology-based assessment system poses numerous challenges. The first challenge is cost—both the upfront investment and ongoing charges. In a Web-based system, investments are needed in central hardware to deliver the test over the Internet, in local telecommunications hardware, in machines in schools for students to take the tests on, and in test authoring and delivery software. Labor expenses include costs for entering questions into the testing system, assuring quality in the test's operation, extracting student records from the test database and translating the information into a form suitable for analysis, and servicing the technology that runs the system. There are also ongoing connection charges.

To mitigate some of these costs, those interested in pursuing electronic assessment can make part-time use of hardware purchased for instruction, use federal e-rate funds to cover telecommunications equipment and connection charges, and outsource test delivery and maintenance services. Savings could also result from the elimination of printing and shipping activities when paper testing ceases. Still, substantial funds will be needed to launch any technology-based assessment program.

Another challenge is ensuring dependability. Computers and the Internet do not always function as desired. Testing sessions may be interrupted, proceed so slowly as to interfere with student performance, or encounter difficulties in machine operation or telecommunications that cause data to be lost entirely. Unlike a paper-and-pencil testing system, keeping a computerized system functioning requires significant technical expertise, which many schools lack.

Security is a third concern. Security issues in a computerized system are conceptually similar to those encountered with conventional tests, though the mechanisms to accomplish breaches and protect against them are different. The issues relate to protecting test questions and to ensuring the integrity and confidentiality of student data. Test questions can be stolen from central servers during transmission or from the local machines students use to take the assessment. The same is true for student data. The good news is that these threats can be minimized through thoughtful technical design (e.g., by encrypting questions and student records) and through sensible administrative procedures (e.g., by closely guarding administrator passwords). These protections are far from perfect, but they are generally as good as, if not better than, the ones available for paper-and-pencil tests.

Last, there are measurement issues. To compare performance equitably, whether among students or against a curriculum standard, it is necessary that each student be tested under the same conditions. However, the reality of statewide computerized testing is that equipment will vary from one school to the next and, sometimes, from one machine to the next within the same school. Similarly, the speed of the Internet connection may differ across schools or within the same school by time of day. The result of these variations is that one student may take a test on a small-screen monitor running at low resolution, thereby requiring repeated scrolling to read comprehension passages. Because of the Internet connection, that student may have to wait five seconds before the next passage is displayed. In contrast, another student may be able to see not only the entire passage but also the questions on the same single screen, with no wait between passages. It is known that such variations can affect performance, but it is not known how to adjust for them in test results.

A second measurement issue relates to computer familiarity. It is true that familiarity is a temporary concern; computers are becoming so widespread in schools that all students will soon be comfortable with them. Yet, until that time, extra care must be taken to ensure that low performance on a computerized test is caused not by lack of familiarity with computers but by low standing in the skill the test is designed to measure.

What Are the Next Steps

While there are significant challenges and risks to computerizing state testing, policymakers can take these steps to help meet the challenges and reduce the risks of technology-based assessment.

Review the initiatives of other states. Eight states are implementing computer-based assessment programs. At least one of these states has already installed high-speed telecommunications lines and computer equipment in all its classrooms, run extensive pilots, and trained a significant portion of its teacher workforce. Much can be learned from these states' successes and failures.

Establish cooperative arrangements. Reinventing the capabilities needed to create or operate computer-based testing programs should be discouraged. It may be possible to form consortia, cooperative agreements, or buying pools that reduce the costs of test questions, telecommunications equipment, computer hardware, testing software, and equipment maintenance.

Develop a comprehensive multi-year plan. It is important to plan as accurately as possible for the costs and time frame for system development and operation. Policymakers should make sure to include contingencies for these activities to cost more and take longer than expected. The plan for an operational Web-based assessment system should comprise relatively small steps. A first step is to develop multiple-choice tests in a small number of subjects in a few grades. These tests should be piloted in a few schools. Then the state can gradually scale up to more schools, more subjects, and more grades as well as scale up to tests that include open-ended questions.

Build experimentation into the assessment plan. It is advisable to plan to fail often but early, when the risks are still tolerable, the embarrassment is bearable, and the number

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of constituents affected is small. Experimentation should occur in a few schools with the best principals and teachers, involving these individuals as collaborators. If they understand they are defining the future of the state's educational assessment system, they will work hard to help. If early ideas do not work under these highly favorable conditions, they surely will not work statewide and should be reconsidered.

Involve people who can think creatively. The money may not be available to do all that is desired, but there may be other ways to get what is needed done. For example, Governor William J. Janklow was able to get South Dakota's schools wired for networking and Internet access, reportedly for a tenth of the quoted cost.[18] The state used carefully screened inmates to do the work. The governor has also managed to provide enough computers and telecommunications capacity to enable almost half of the state's students to be online simultaneously.

Plan for a single technology infrastructure. The power of Internet connectivity for schools is in the vast resources it makes available for learning. It is important to plan for one integrated digital network that can serve testing, instruction, and staff development needs, rather than for a system that serves only testing purposes. If the state has already made large technology infrastructure investments for instructional purposes, it may be possible to extend those investments to also satisfy testing needs.

Use the assessment for the purposes for which it was designed. Regardless of whether tests are delivered on paper or through technology, using a test for purposes that go beyond its original design encourages misinformation, bad decisions, and disillusionment with assessment.

Plan to go beyond delivering conventional tests by computer. Delivering tests on computers will eventually produce important efficiencies. Yet efficiency is not the end goal. The end goal is to leverage technology to create assessments that help teachers instruct and students learn. Taking such a test should be a learning experience. Moreover, the test should provide detailed information that suggests specific actions that students, teachers, parents, and education officials can take to move toward achieving meaningful performance standards. In concert with the federal government and their colleagues in other states, governors can provide the political and financial leadership needed to encourage the development and deployment of these new assessments.

Do not forget why electronic assessment is desired. Electronic assessment will enable states to get test results to schools faster and, eventually, cheaper. It will help ensure assessment keeps pace with the tools that students are using for learning and with the ones that adults are increasingly using at work. The technology will also help schools improve and better prepare students for the next grade, for postsecondary learning, and for the workforce.

Randy Elliot Bennett is Distinguished Presidential Appointee at Educational Testing Service (ETS). *This article, in a slightly different version, was published as an Issue Brief by the National Governors Association's Center for Best Practices. Portions of the brief are also based on "How the Internet Will Help Large-Scale Assessment Reinvent Itself," published in* Education Policy Analysis Archives *9, no. 5 (February 2001), available online at epaa.asu.edu/epaa/v9n5.html.*

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1. P. E. Barton, *What Jobs Require: Literacy, Education, and Training, 1940–2006* (Princeton, NJ: Policy Information Center, Educational Testing Service, 1999), available online at www.ets.org/research/pic; and A.P. Carnevale and D.M. Desrochers, *Help Wanted ... Credentials Required* (Princeton, NJ: Educational Testing Service, 2001).
2. M. T. Moe and H. Blodget, *The Knowledge Web: People Power—Fuel for the New Economy* (San Francisco, CA: Merrill Lynch, 2000).
3. D. Henry, P. Buckley, G. Gill, S. Cooke, J. Dumagan, D. Pastore, and S. LaPorte, *The Emerging Digital Economy II* (Washington, DC: U.S. Department of Commerce, 1999), available online at www.ecommerce.gov/ede/ede2.pdf.
4. B. Kerrey and J. Isakson, *The Power of the Internet for Learning: Moving from Promise to Practice—Report of the Web-based Education Commission* (Washington, DC: Web-based Education Commission, 2000), available online at interact.hpcnet.org/webcommission/index.htm.
5. "Education Prognosis 1999," *Business Week*, 1 January 1999, 132–133.
6. F. Newman and J. Scurry, "Online Technology Pushes Pedagogy to the Forefront," *The Chronicle of Higher Education* (2001), available online at http://chronicle.com/weekly/v47/i44/44b00701.htm.
7. Moe and Blodget, *The Knowledge Web*.
8. D. Walfish, "Chinese Government Predicts Strong Growth in Online Education," *The Chronicle of Higher Education* (2001), available online at chronicle.com/free/2001/05/2001052101u.htm.
9. "Technology Counts 2002: E-Defining Education," *Education Week*, 9 May 2002.
10. Visit apex.netu.com/.
11. Commission on Technology and Adult Learning, *A Vision of E-Learning for America's Workforce* (Alexandria, VA: American Society for Training and Development and Washington, DC: National Governors Association, 2001), 27.
12. Kerrey and Isakson, *The Power of the Internet for Learning*, 59.
13. R. E. Bennett, *Reinventing Assessment: Speculations on the Future of Large-Scale Educational Testing* (Princeton, NJ: Policy Information Center, Educational Testing Service, 1998), available online at ftp.ets.org/pub/res/reinvent.pdf.
14. R. E. Bennett, M. Goodman, J. Hessinger, J. Ligget, G. Marshall, H. Kahn, and J. Zack, "Using Multimedia in Large-Scale Computer-Based Testing Programs," *Computers in Human Behavior* 15 (1999): 283–294.
15. C. Thompson, "New Word Order: The Attack of the Incredible Grading Machine," *Linguafranca* 9, no. 5 (1999), available online at www.linguafranca.com/9907/nwo.html.
16. R. E. Bennett, "How the Internet Will Help Large-Scale Assessment Reinvent Itself," *Education Policy Analysis Archives* 9, no. 5 (2001), available online at epaa.asu.edu/epaa/v9n5.html.
17. South Dakota Department of Education and Cultural Affairs, "DACS [Dakota Assessment of Content Standards]: DACS FAQs," available online at www.state.sd.us/deca/dacs/.
18. Oregon Department of Education, "TESA FAQ," available online at www.ode.state.or.us/asmt/faqs/faqtesa.htm#8.
19. Virginia Department of Education, "General Questions," available online at www.pen.k12.va.us/VDOE/Technology/soltech/FAQ/DetailedFAQ.html.
20. M. Patterson, personal communication, 23 October 2000. Also visit www.nwea.org/PRODUCTS/MAP.htm.
21. Visit www.intellimetric.com/when.newstoday0.html.
22. P. Evans and T. S. Wurster, *Blown to Bits: How the Economics of Information Transforms Strategy* (Boston, MA: Harvard Business School Press, 2000).
23. Visit www.dell.com.
24. Visit www.customatix.com/customatix/common/homepage/HomepageGeneral.po?.
25. Visit www.knowledge-technologies.com or www.etstechnologies.com/ for demonstrations.
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